

BATSE:

The History and Legacy

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1973

**GRBs: First Public
Presentation:**

AAS Meeting – Columbus, Ohio

**Huntsville Group - Decided to build a
large-area detector balloon experiment to
detect weak GRBs**

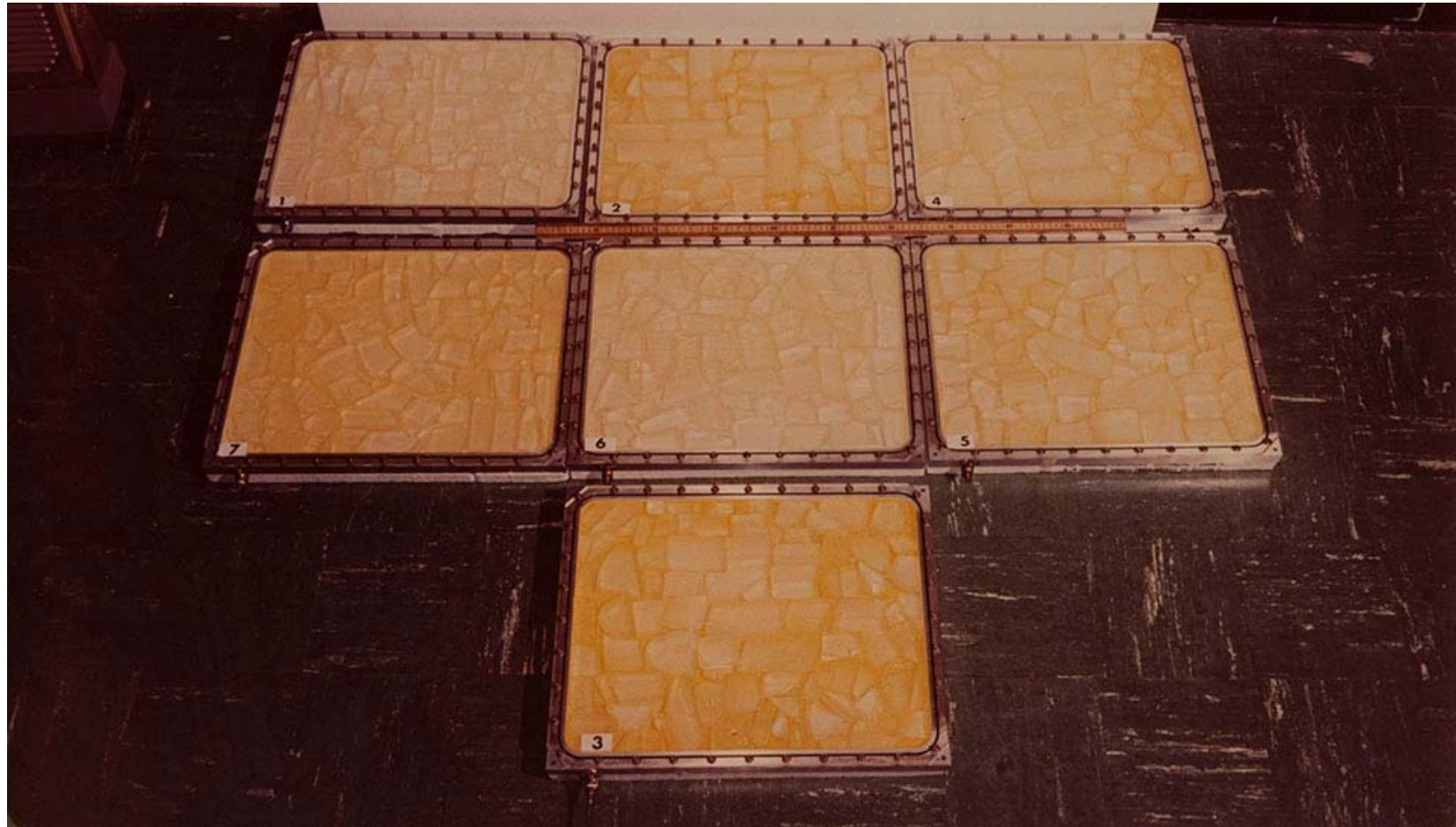
1974-1977

**Detector Development
&
Early Balloon Flights**



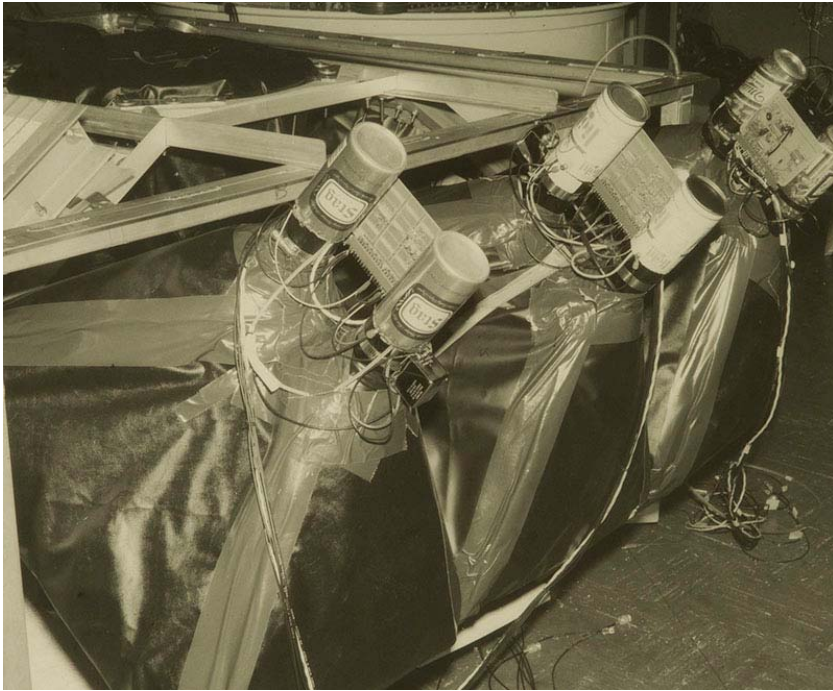
**A single large area detector tray
made from NaI (TI) Crystal pieces**





A group of seven NaI(Tl) detector trays developed for balloon flight observations of GRBs.

**Notice the variation in the amount of hydration (yellowing) of the crystals in the different trays.
To our surprise, this hydration was largely reversible by pumping the interior of the trays for long periods and removing the moisture.**



A group of three detectors arranged to view the same direction. The PMTs view each detector tray.

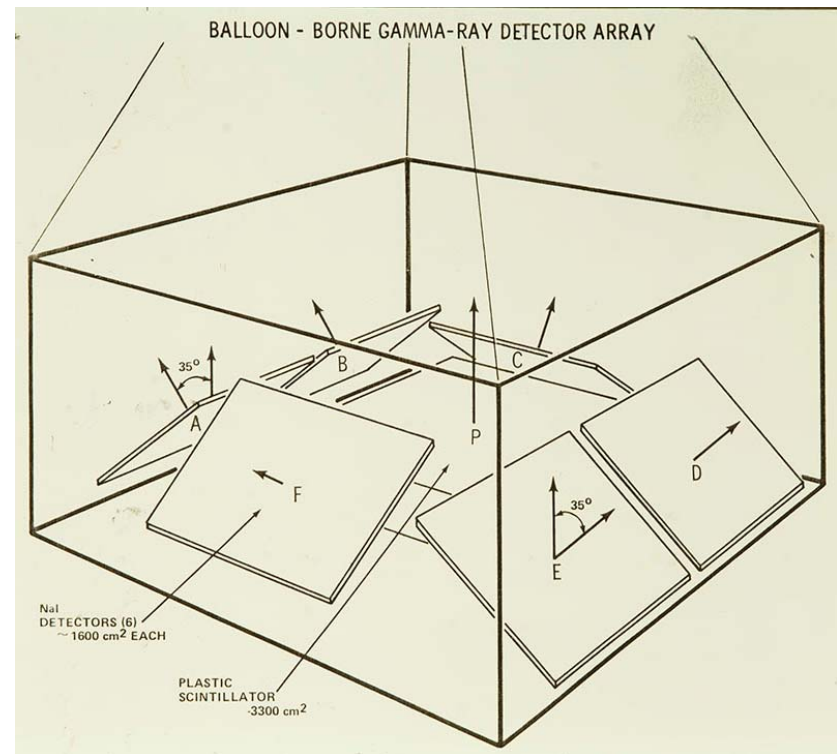


Diagram of the detectors viewing different directions on a balloon flight gondola

1977-1978

GRO Announcement of Opportunity (AO)

- Proposed Transient Event Monitor (TEM)**
- Twelve Detectors (Dodecahedron)**
- Six on Top & Six on Bottom of Spacecraft**
- Partial Selection – 6 Det.**
 - only on bottom of spacecraft**

1979-1980

Negotiating after Approval

- TEM Name changed to BATSE**
- Requested Eight Detectors**
(Octahedron - Four on top & bottom)

GAMMA-RAY OBSERVATORY

CONCEPTUAL DESIGN

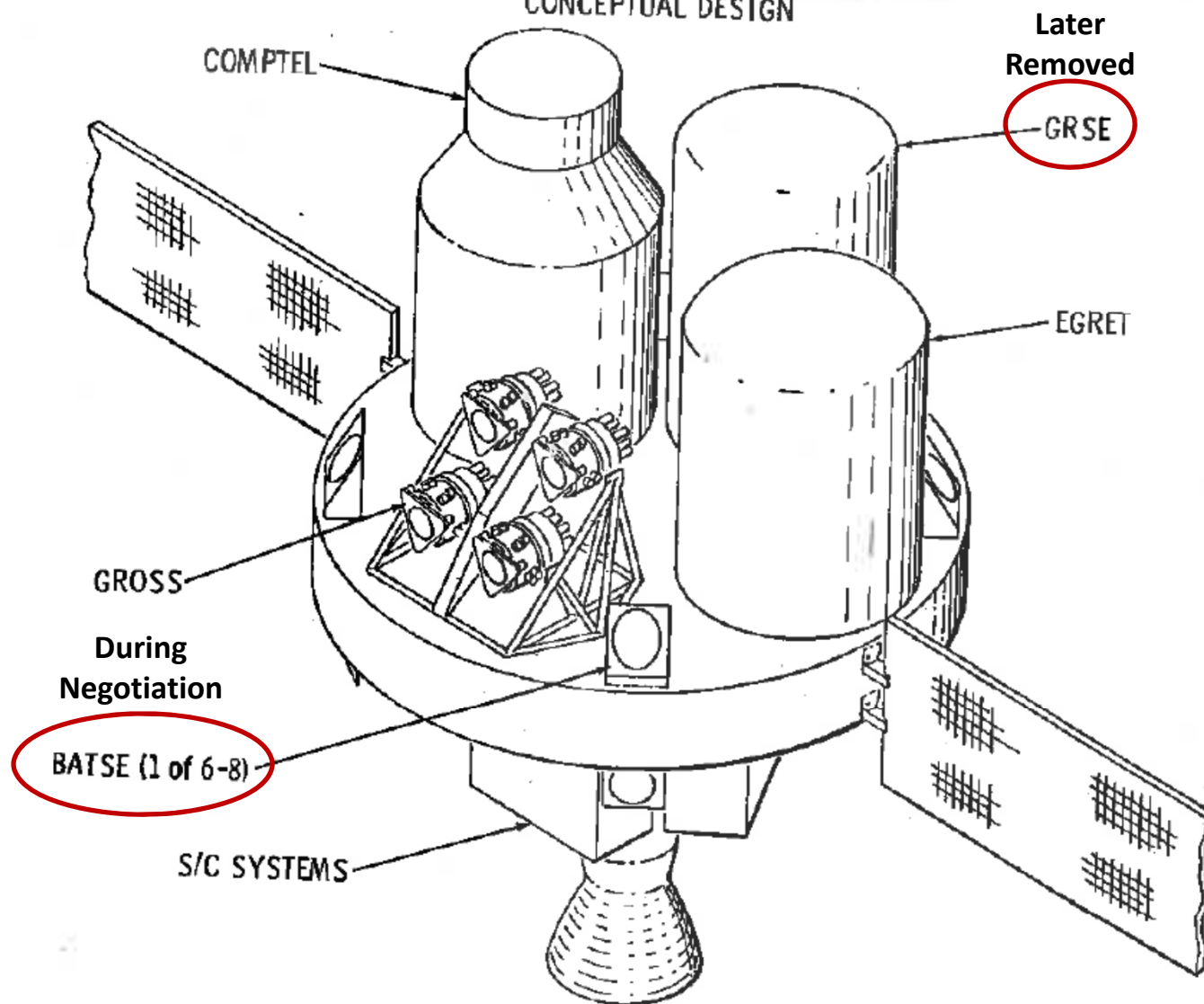
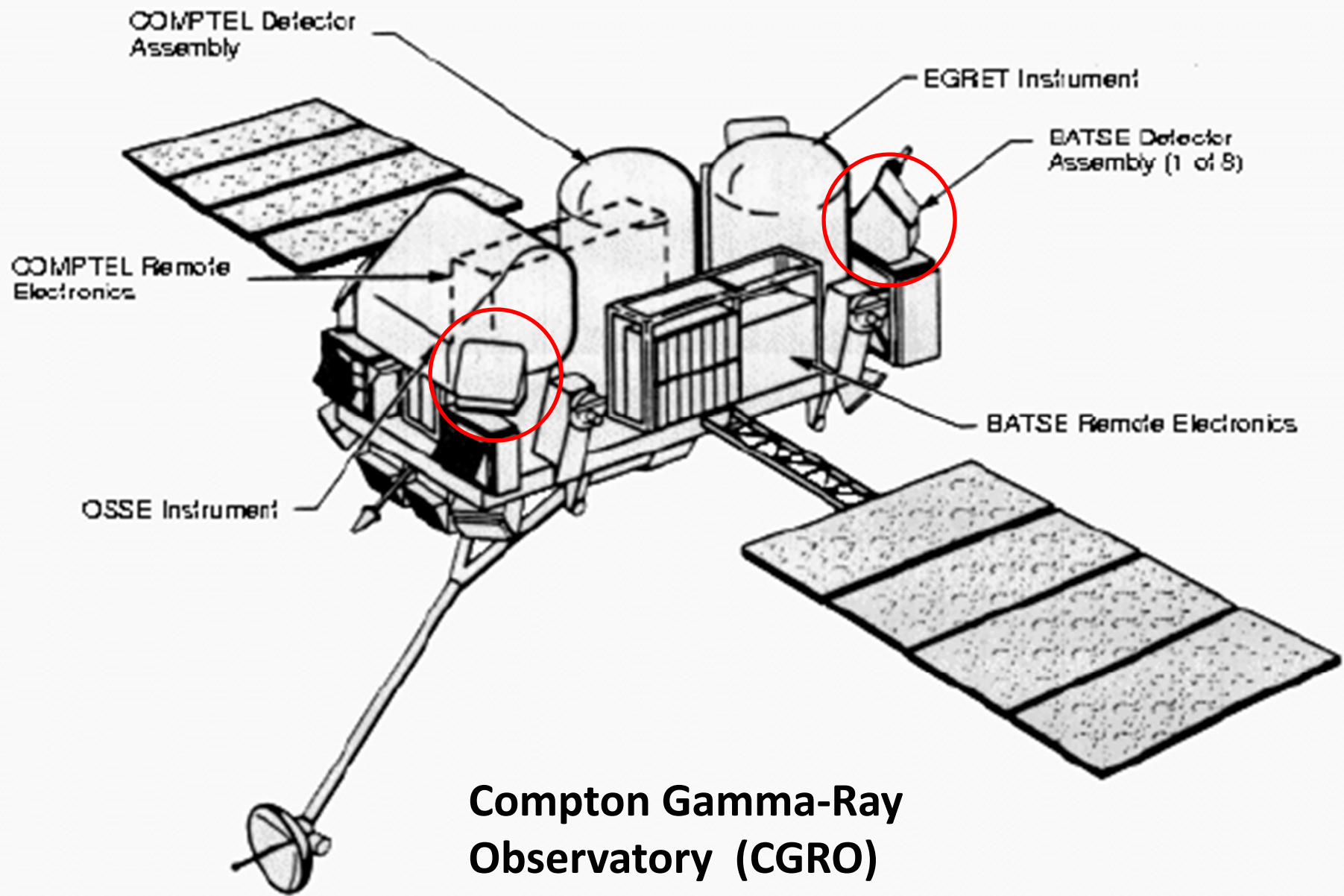


Fig. 3. Conceptual drawing of the planned Gamma-Ray Observatory (GRO) showing the four major pointed experiments and a possible configuration for the BATSE array.

1981-1982

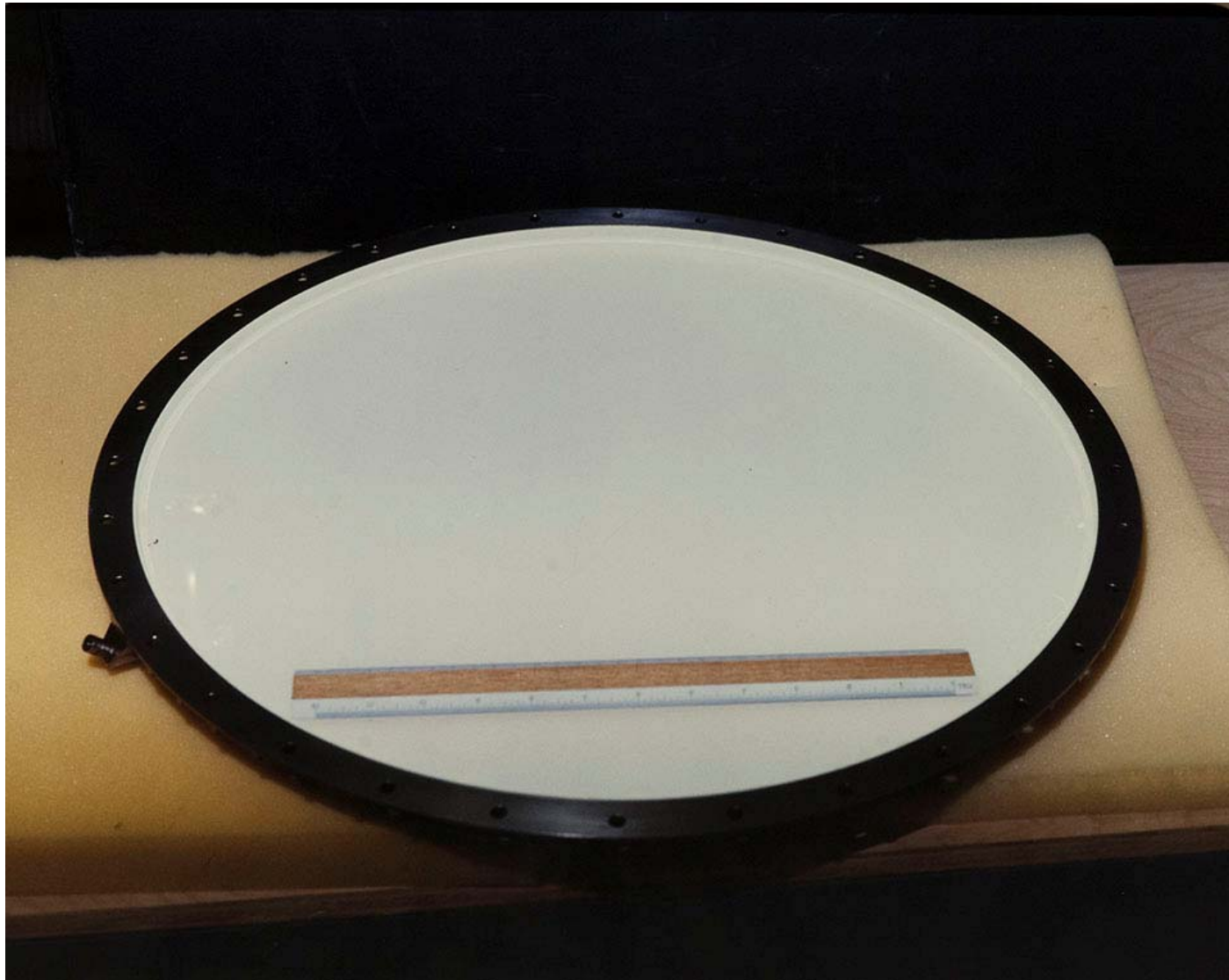
- GRSE Experiment Removed from GRO**
- Spectroscopy Detectors added to BATSE,
one in each detector module**



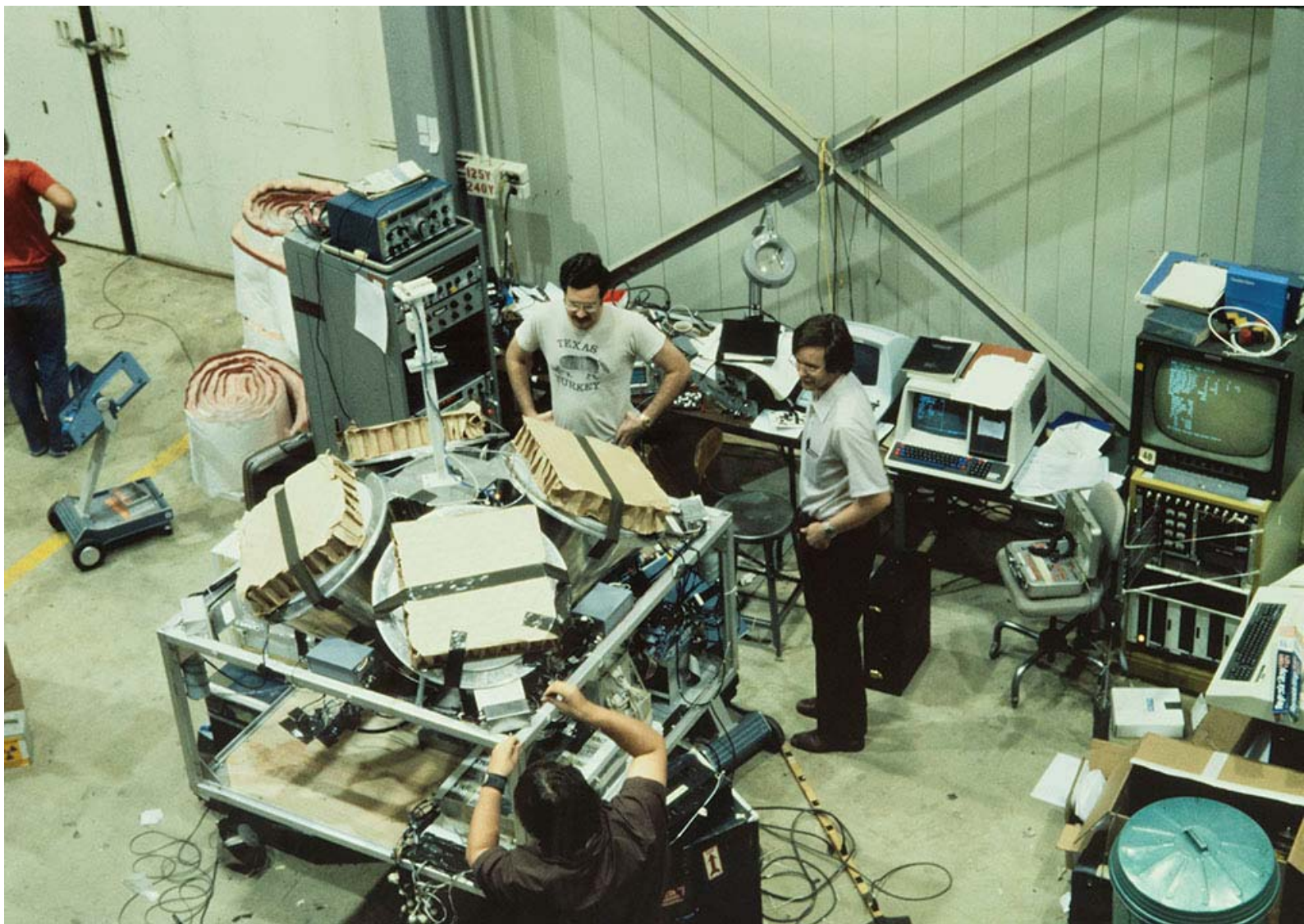
1982 – 1988

**BATSE Detector Development
& Balloon Flights**

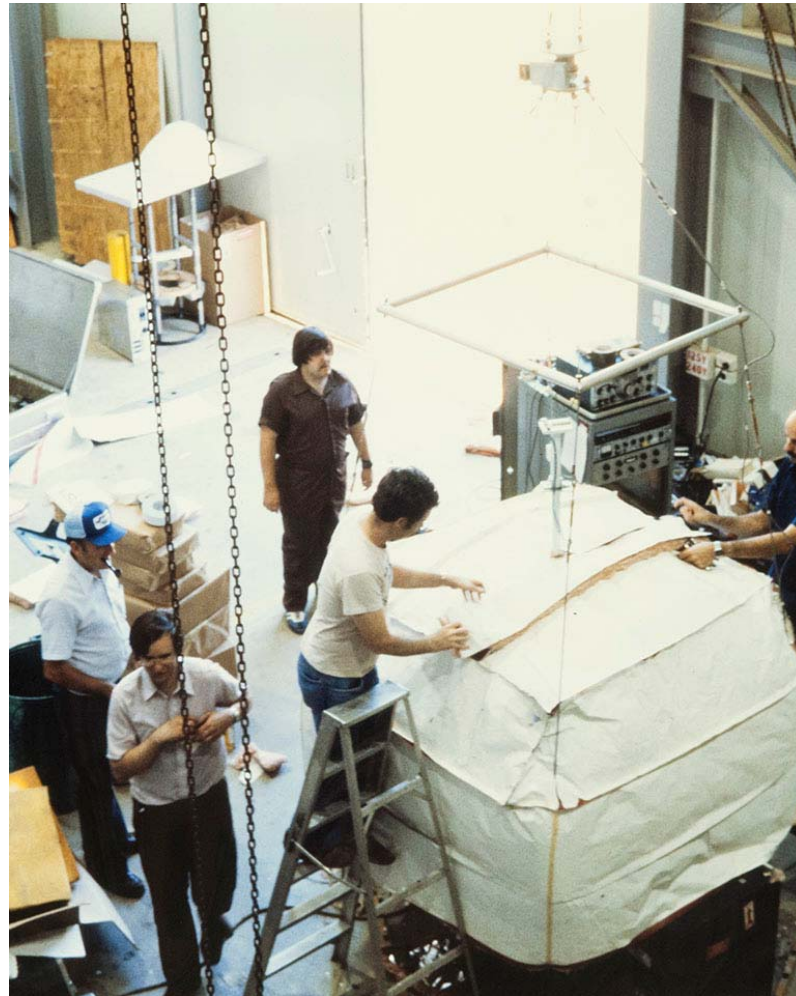
BATSE LAD NaI Detector Element: 20" dia; 2025 cm²



Preparing Four BATSE LAD NaI Prototype Detectors on a Gondola for Balloon Flight from Palestine, TX



Preparing Four BATSE LAD NaI Prototype Detectors on a Gondola for Balloon Flight from Palestine, TX (cont.)

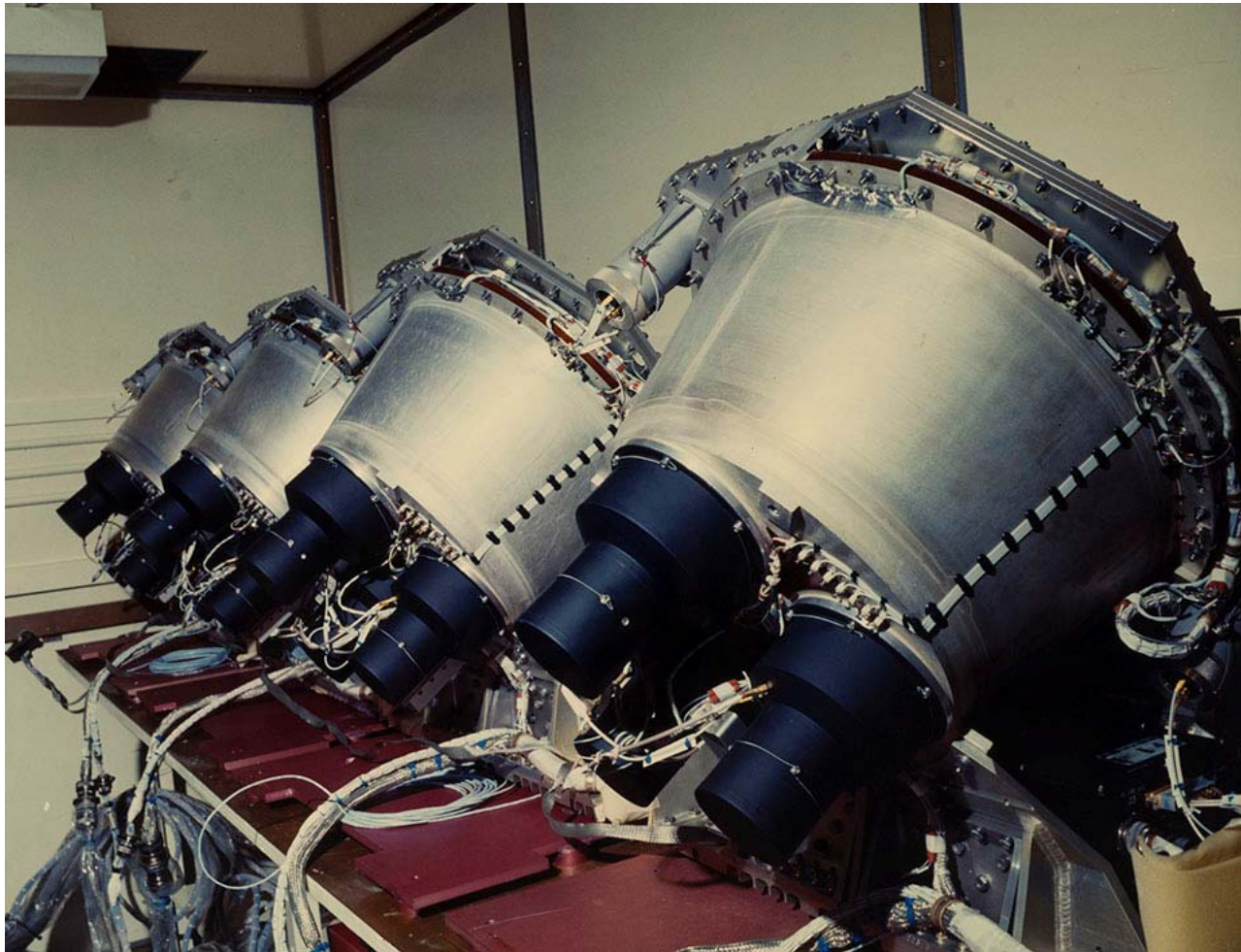


BATSE Prototype Balloon-flight Gondola about to be Launched from Palestine, TX



BATSE Detector Modules:

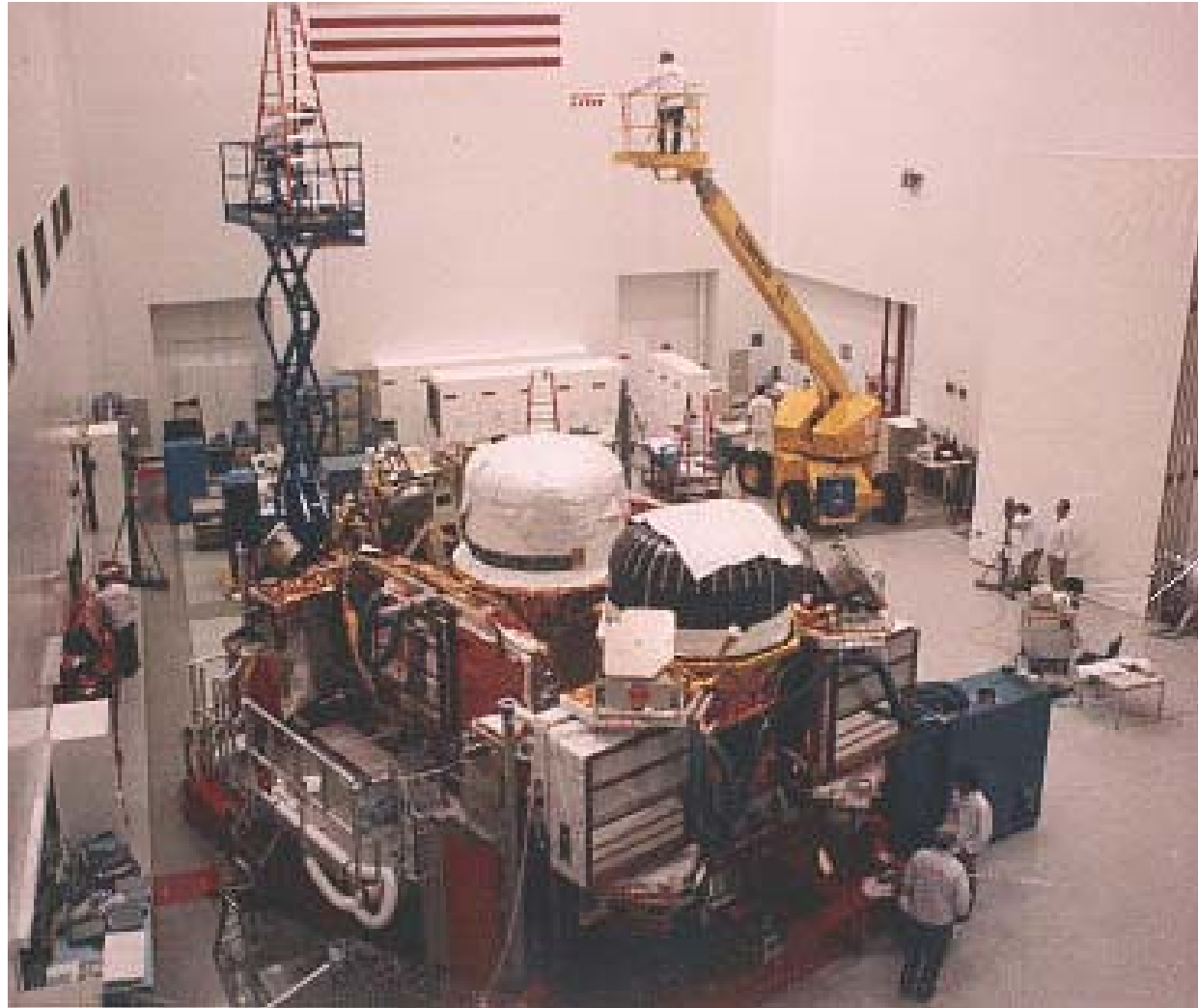
- Design, Fabrication, Testing & Calibration
at NASA-MSFC: 1982 - 1989**



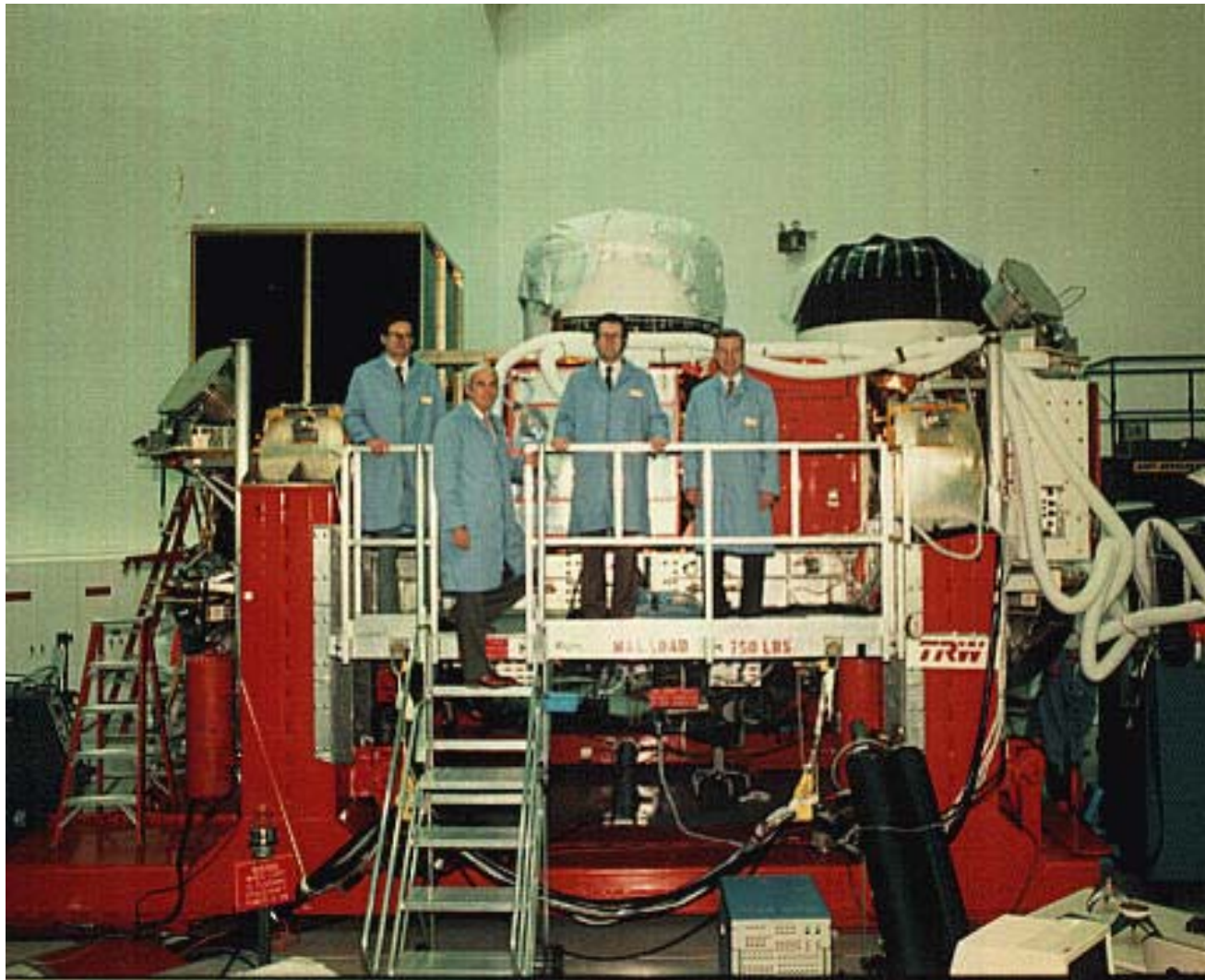
Integration of Experiments on GRO Spacecraft in California



Radioactive Source Survey of BATSE on the GRO Spacecraft in



GRO Four P.I.s at the GRO Instruments TRW Facility, Redondo Beach CA



April 4-5, 1991:

**Launching
&
Deploying GRO**

April 4, 1991

**Shuttle launch,
STS-37**

**Gamma-Ray
Observatory (GRO)**

**(Operational:
re-named CGRO)**



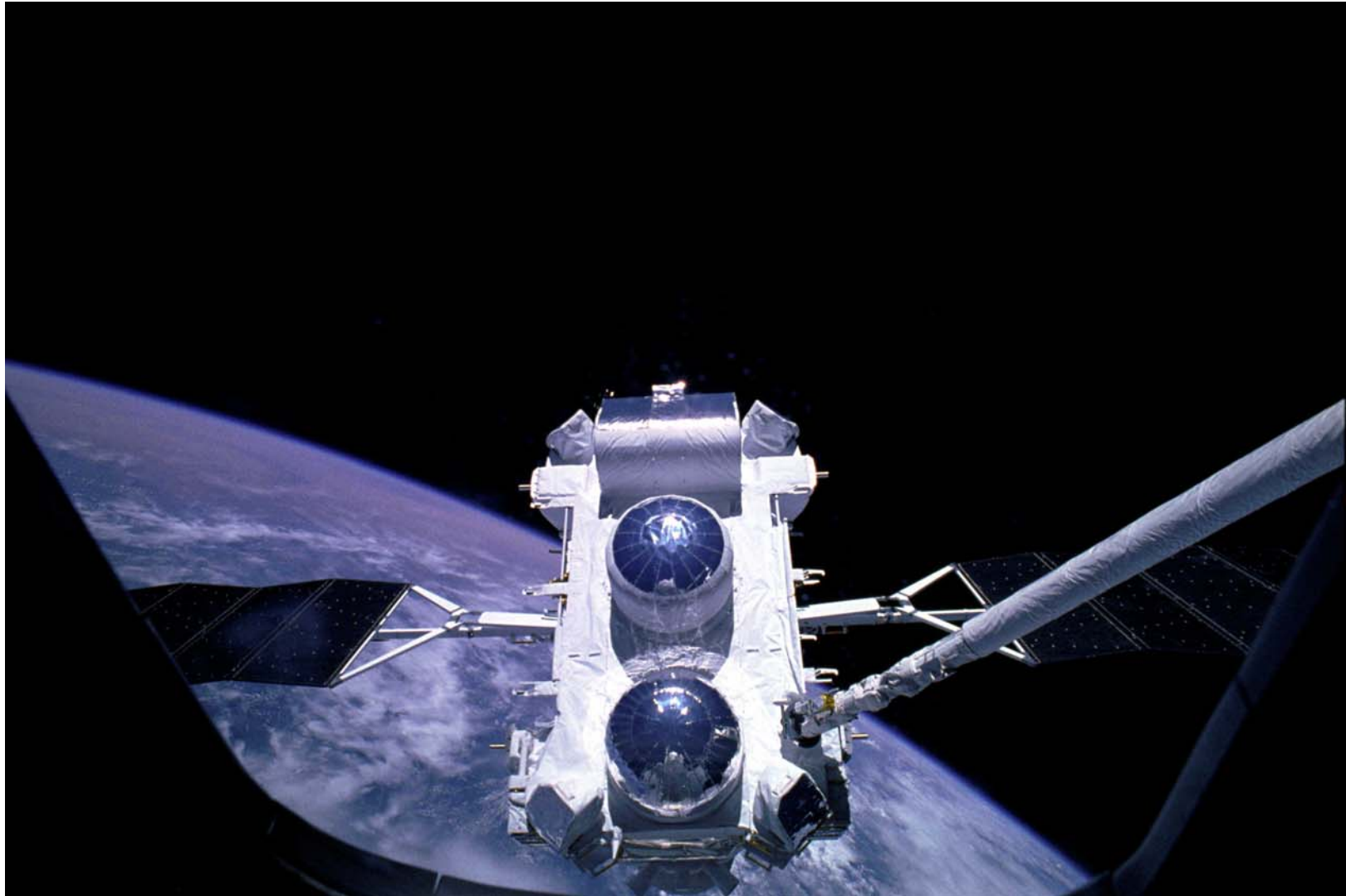
STS-37 Flight Crew – After GRO Deployment In Orbit

Linda Godwin Holding Flight Patch

c

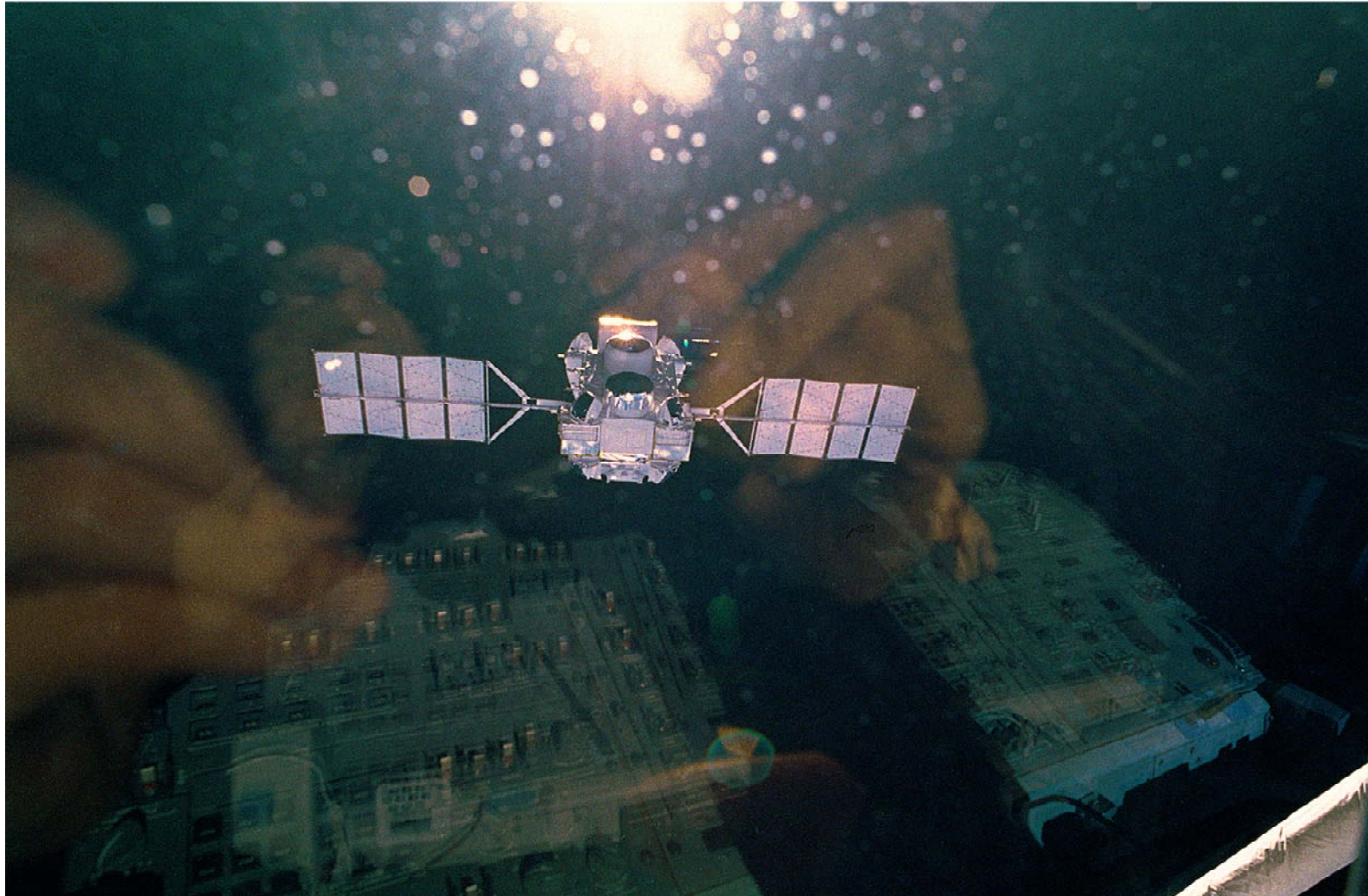


GRO Spacecraft – Still Attached to Shuttle Arm, Just Prior to Deployment



GRO Spacecraft Drifting Away, Just After Deployment

(Note reflection of Linda Godwin's hands holding camera)



GRO on Cover of *Nature*, Jan. 9, 1992



BATSE - Unique

First large experiment designed for GRB studies:

- Full-sky
- Large area
- Good sensitivity for E_{peak} of most GRBs
- Moderate spectral capabilities – (good enough for most time/spectral correlations and time resolved spectral studies)

BATSE (cont.)

- Largest sample (2704 GRBs); full-sky, 9+ years in operation
 - Well- characterized, full-sky instrument
 - Likely will not be exceeded for several decades
 - Led to GCN Network
- Many Hundreds of Papers Based on
BATSE Observations; >50 Ph.D. theses

**A Few Major BATSE
GRB Results,
1991-2000**

➤ **Global properties of GRB Distributions:**

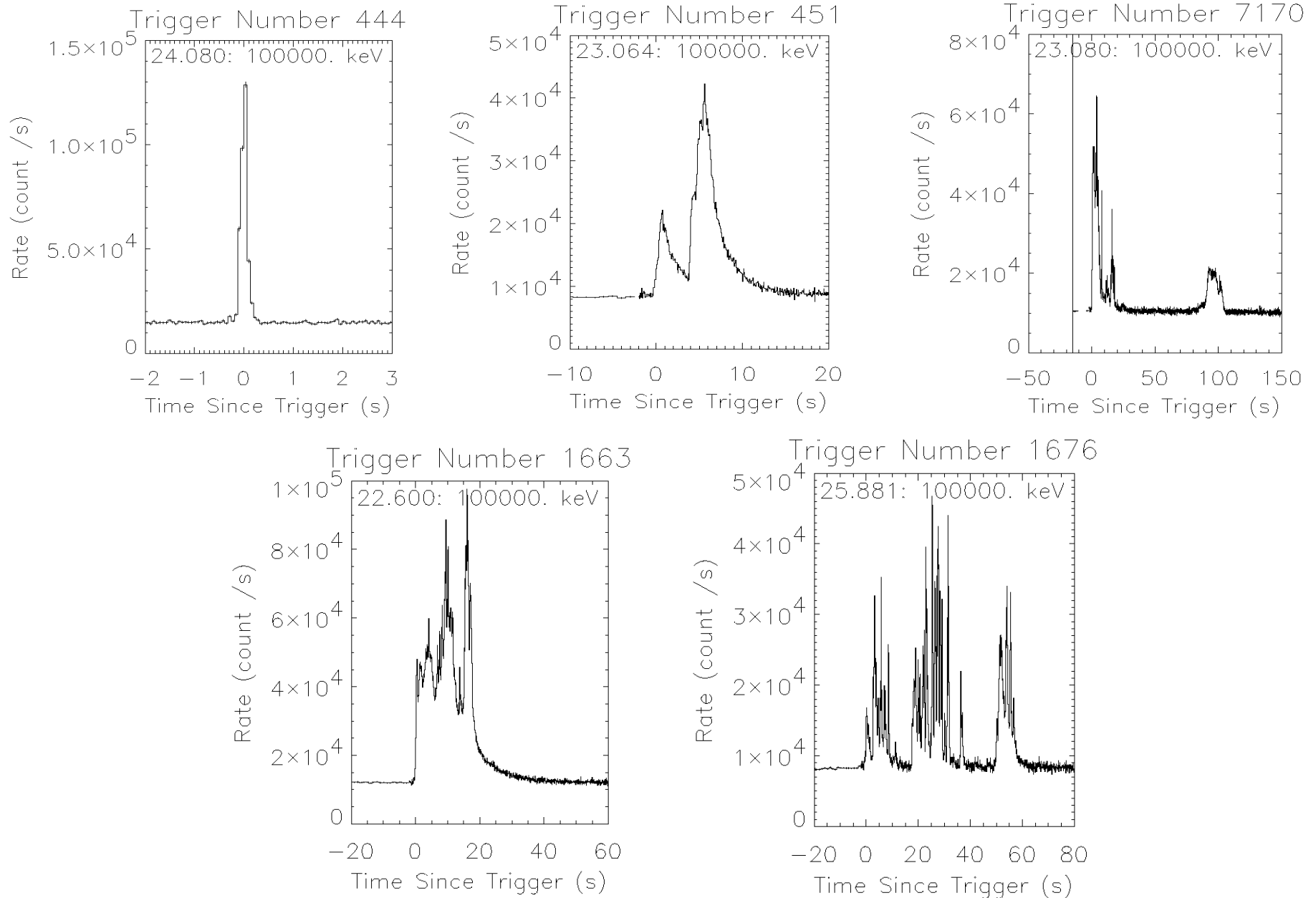
- **Intensity Distribution & Sky Distribution**
- **Not consistent with any Galactic Distribution, nearby extragal objects, incl. large clusters**
- **Strong Indications that GRBs were at cosmological distances (Although BeppoSAX nailed it)**

➤ **Comprehensive Temporal/Spectral Studies**

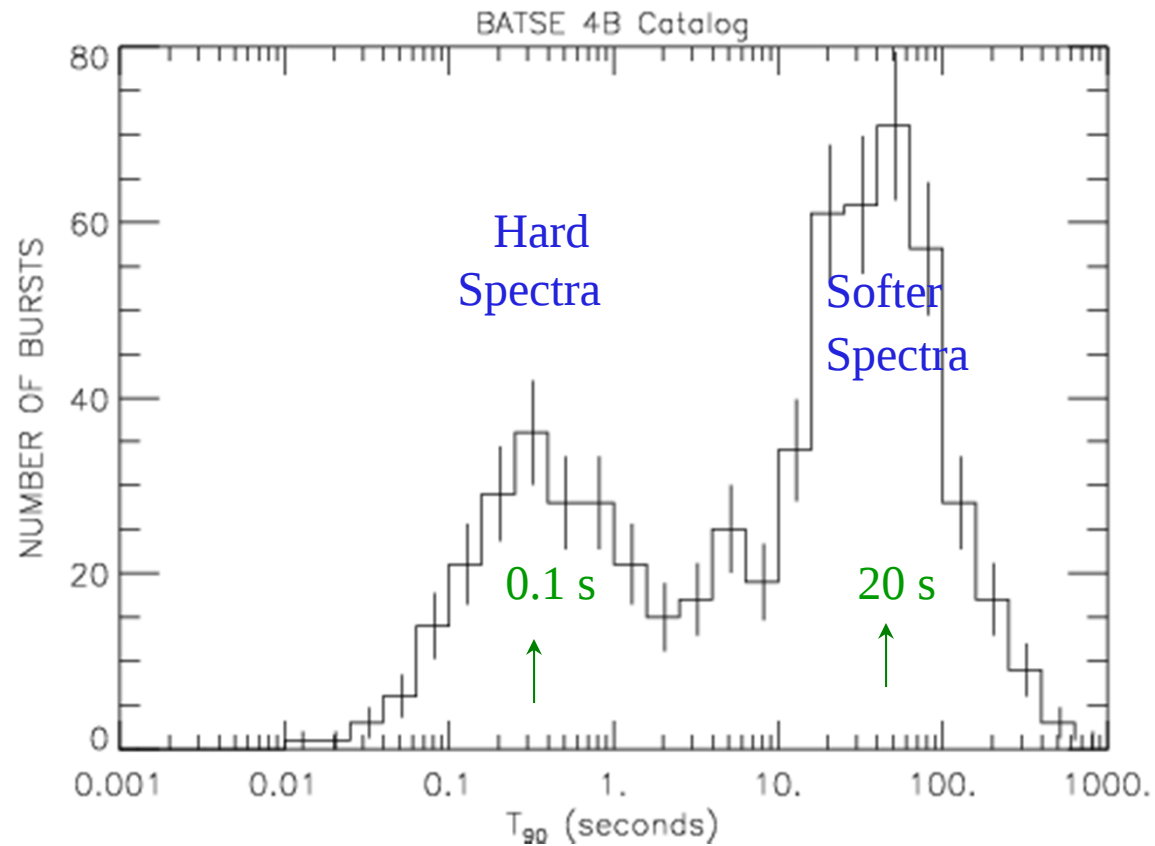
➤ **Two Populations of GRBs**

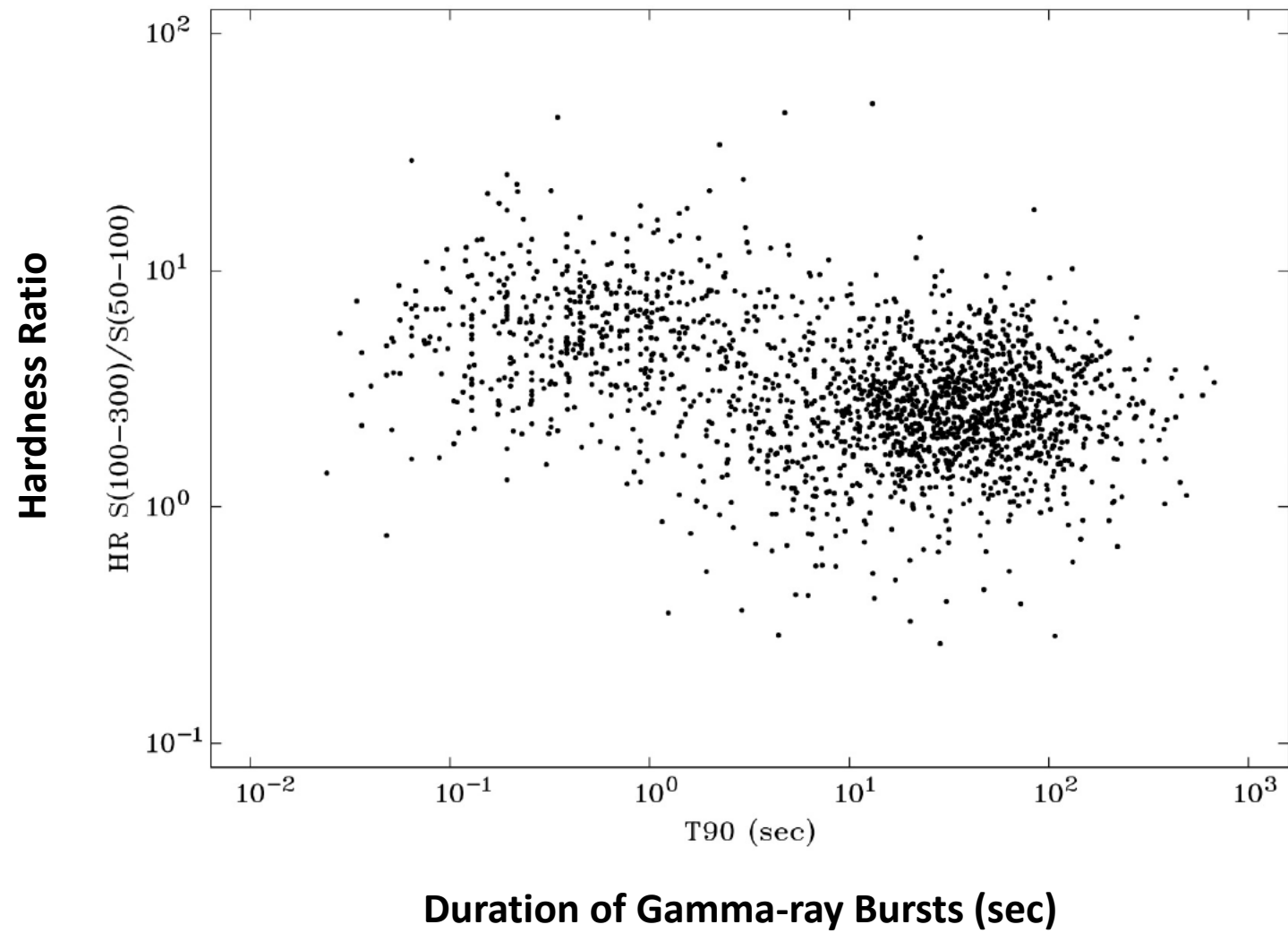
- ## ➤ **Rapid GRB Response:**
- **beginning of Bacosine/GCN**
 - **led to breakthrough quick, wide-field observations**

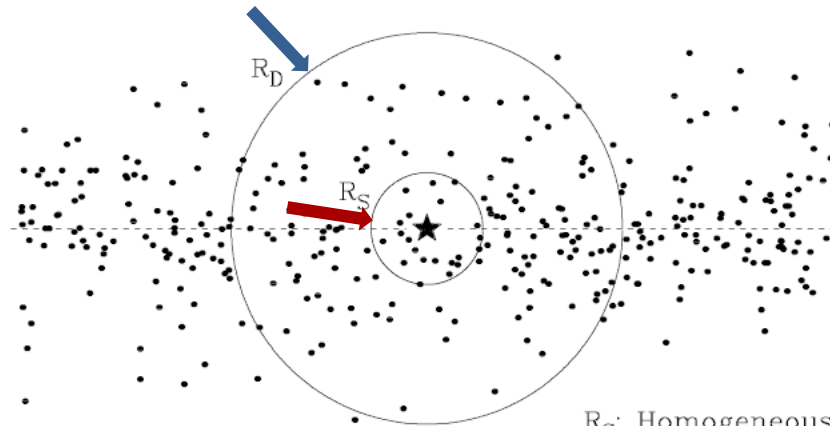
Diversity of GRB Profiles & Coupled Spectral / Temporal Properties



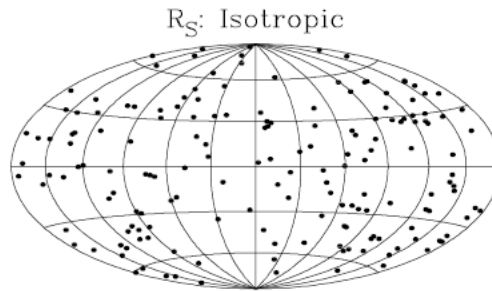
Two Distinct subclasses of γ -ray bursts: short/hard & long/soft





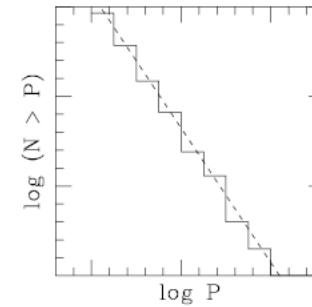


R_S - Galactic, Nearby

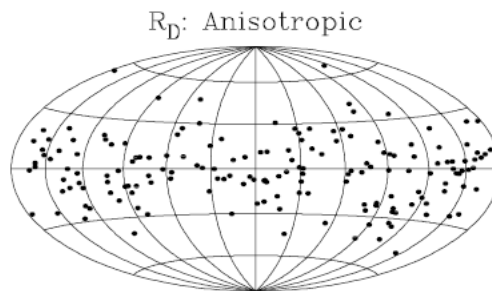


R_S : Isotropic

R_S : Homogeneous

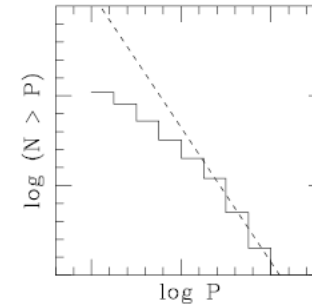


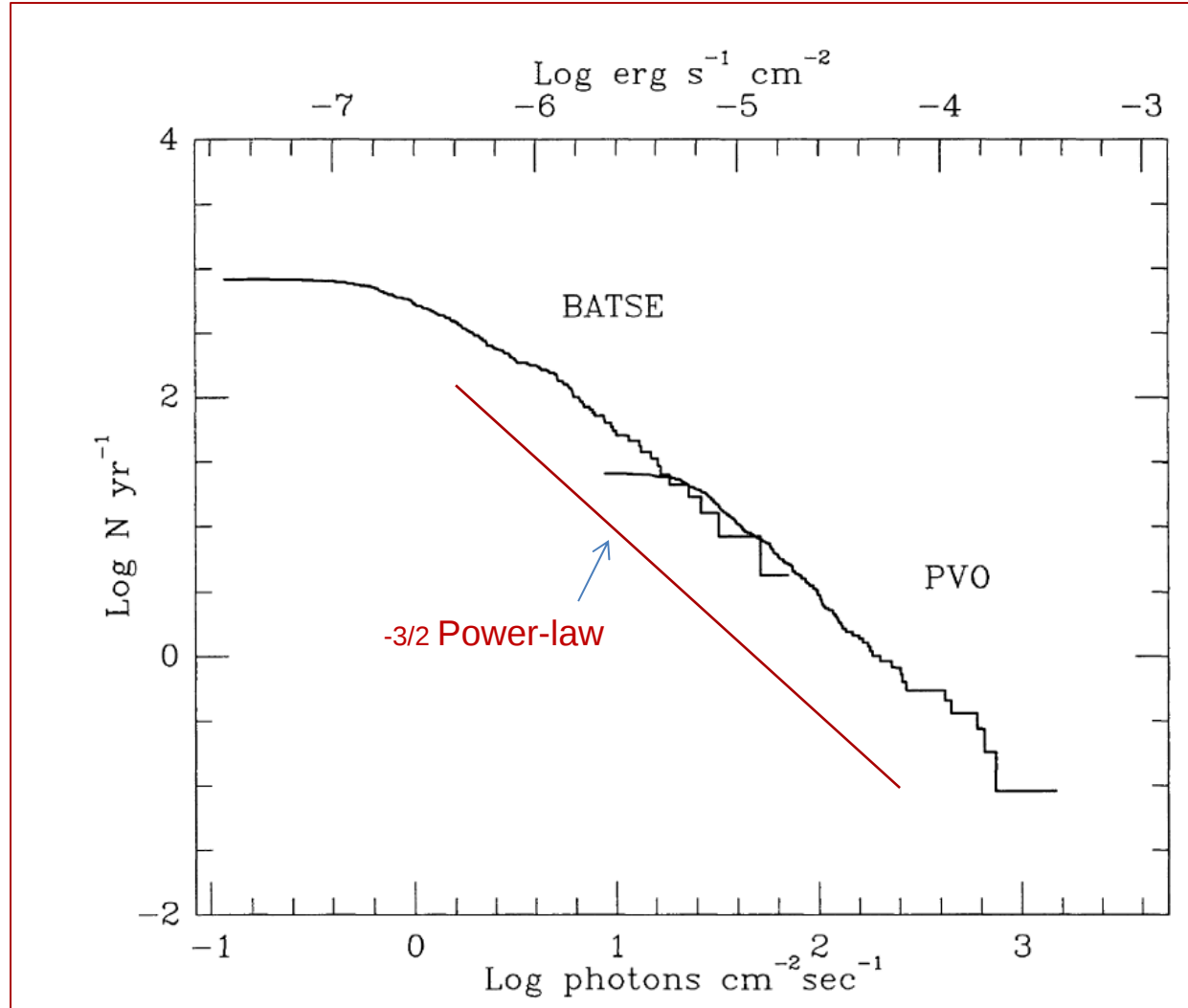
R_D - Galactic, Far away



R_D : Anisotropic

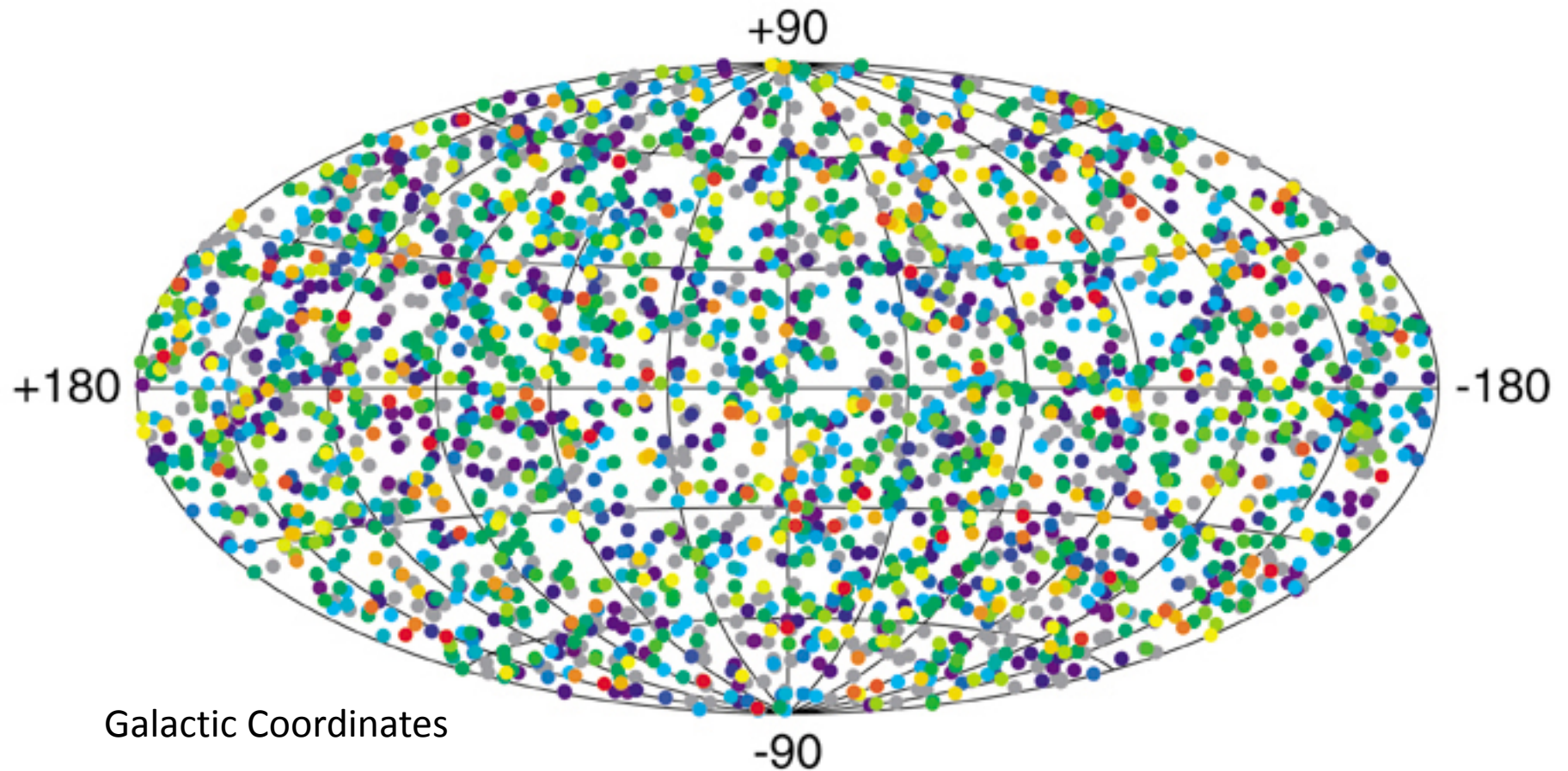
R_D : Inhomogeneous



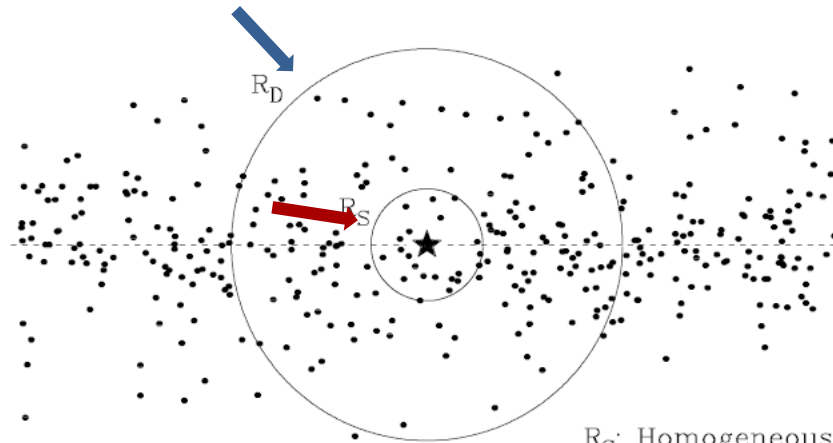


Observed Frequency of GRBs

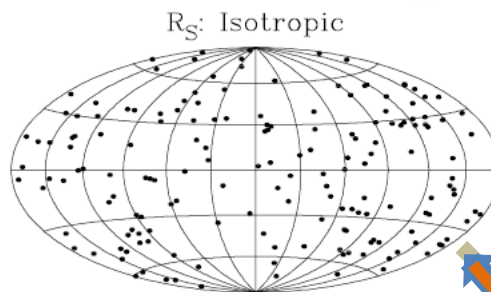
2704 BATSE Gamma-Ray Bursts



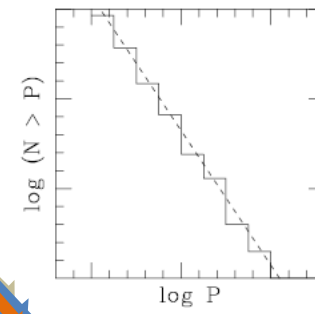
Apr. 1991 – May 2000



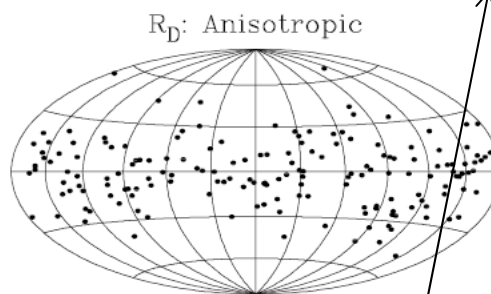
R_S - Galactic, Nearby



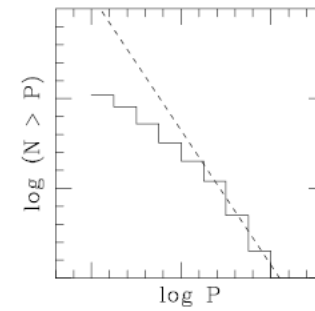
R_S : Homogeneous



R_D - Galactic, Far away



R_D : Inhomogeneous



Observed Distribution

i.e. Not Galactic

Some Recent Papers that use BATSE Data:

van Putten, M. H. P. M.

Discovery of Black Hole Spindown in the BATSE Catalogue of Long GRBs

2012 - Progress of Theoretical Physics, Vol. 127, No. 2, pp. 331-354

Nava, L.; Ghirlanda, G.; Ghisellini, G.; Celotti, A.

Fermi/GBM and BATSE gamma-ray bursts: comparison of the spectral properties

2011 - Monthly Notices of the Royal Astronomical Society, Volume 415, Issue 4, pp. 3153-3162

Tikhomirova, Ya. Yu.; Pozanenko, A. S.; Hurley, K. S

Search for nearby host galaxies of short gamma-ray bursts detected and well localized by BATSE/IPN

2010 - Astronomy Letters, Volume 36, Issue 4, pp.231-236

Burlon, D.; Ghirlanda, G.; Ghisellini, G.; Greiner, J.; Celotti, A.

Time resolved spectral behavior of bright BATSE precursors

2009 - Astronomy and Astrophysics, Volume 505, Issue 2, 2009, pp.569-575

Huja, D.; Mészáros, A.; Řípa, J.

A comparison of the gamma-ray bursts detected by BATSE and Swift

2009 - Astronomy and Astrophysics, Volume 504, Issue 1, 2009, pp.67-71

**González, M. M.; Carrillo-Barragán, M.; Dingus, B. L.; Kaneko, Y.; Preece, R. D.; Briggs, M. S.
Broadband, Time-Dependent, Spectroscopy of the Brightest Bursts Observed by BATSE LAD
and EGRET TASC**

2009 - The Astrophysical Journal, Volume 696, Issue 2, pp. 2155-2169 (2009).

Horváth, I.; Veres, P.; Balázs, L. G.

The Third Group of Gamma-Ray Bursts in the Swift and BATSE Data

2009 - Baltic Astronomy, Vol. 18, p. 302-304

Some Recent Papers that used BATSE Data (cont.) :

Tsutsui, Ryo; Nakamura, Takashi; Yonetoku, Daisuke; Murakami, Toshio; Tanabe, Sachiko; Kodama, Yoshiki

Redshift-dependent lag-luminosity relation in 565 BATSE gamma-ray bursts¹⁰

Monthly Notices of the Royal Astronomical Society: Letters, Volume 386, Issue 1, pp. L33-L37

**Kaneko, Yuki; González, M. Magdalena; Preece, Robert D.; Dingus, Brenda L.; Briggs, Michael S.
Broadband Spectral Properties of Bright High-Energy Gamma-Ray Bursts Observed with BATSE and EGRET**

The Astrophysical Journal, Volume 677, Issue 2, pp. 1168-1183

**Bosnjak, Z.; Celotti, A.; Longo, F.; Barbiellini, G.
Energetics-spectral correlations versus the BATSE gamma-ray bursts population
2008 - Monthly Notices of the Royal Astronomical Society, Volume 384, Issue 2, pp. 599-604**

**Ashcraft, Teresa; Schaefer, Bradley E.
Are There Any Redshift >8 Gamma-Ray Bursts in the BATSE Catalog?
2007 - The Astrophysical Journal, Volume 671, Issue 2, pp. 1896-1902**

**Tsuchiya, H.; Miyasaka, H.; Takahashi, E.; Shimoda, S.; Yamada, Y.; Kondo, I.; Makishima, K.; Zhu, F.; Tan, Y.; Hu, H.; and 4 coauthors
Upper limits on the solar-neutron flux at the Yangbajing neutron monitor from BATSE-detected solar flares
2007 - Astronomy and Astrophysics, Volume 468, Issue 3, June IV 2007, pp.1089-1097**

**Hakkila, Jon; Giblin, Timothy W.; Young, Kevin C.; Fuller, Stephen P., et al.
A Gamma-Ray Burst Database of BATSE Spectral Lag and Internal Luminosity Function Values
The Astrophysical Journal Supplement Series, Volume 169, Issue 1, pp. 62-74**

**Alothman, M. J.; Azzam, W. J.
Fluence correlations across the BATSE gamma-ray burst energy channels for short and long bursts
2007 - Advances in Space Research, Volume 40, Issue 8, p. 1229-1232**

The End